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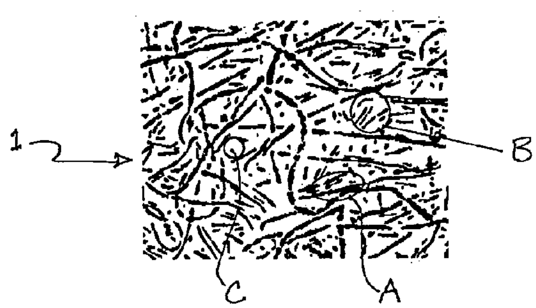
(54) **Press felt with improved drainage**

(57) A three layer papermaking press section press felt in which the first layer comprises a core fabric which contains the mechanical loads placed upon the press felt, the second layer comprises a layer of absorbent material, typically a batt needle punched onto the core fabric, and the third layer comprises a porous layer attached to the surface of the absorbent layer. The third layer receives the wet paper web. The three layer press felts remove from about 3% to at least about 5% more water from the wet paper web under pressure in a press section in comparison with the same press felt to which the third porous layer has not been added.

FIGURE 1



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Description

BACKGROUND OF THE INVENTION.

[0001] This invention is concerned with composite fabrics known as "press felts" used in the press section of a paper making machine.

[0002] In the press section of a paper making machine, the wet paper web is carried by at least one press felt, upon which the wet paper is passed through at least one nip between either a pair of rotating opposed rollers, or between a single rotating roller and a device known as a "shoe", in what is known as a shoe press. For simplicity, in the following discussion reference will mainly be made to a conventional two roll press, but it is to be understood that it is not limited only to that device; the comments and concepts are equally applicable to a shoe press. In the nip or nips, the press felt carrying the wet paper web is exposed to compressive pressures ranging from about 3MPa to at least about 18MPa. The applied pressure serves to expel a proportion of the water in the wet paper web; the expelled water is the carried away by the press felt. In the press section, the paper consistency, which is defined as the percentage by weight of paper making solids in the web, will increase from a value as low as 15% on entry to the press section, to a value of the order of 60%.

[0003] In addition to resisting the imposed compressive forces and permitting transport of the expelled water, the press felt must also be able to resist and contain the forces imposed upon it in order to move the press felt, and the paper web carried by it, through the paper making machines: modern paper making machines can operate at a linear speed in excess of 75kph.

[0004] In the following discussion, two terms are used to have particular meanings:

(i) the term "paper side surface" refers to a surface of a layer or fabric which is toward the wet paper web carried by the press felt; and

(ii) the term "machine side surface" refers to a surface of a layer or fabric which is away from the wet paper web carried by the press felt.

[0005] The known press felts are generally comprised of essentially two components, a core fabric and an absorbent layer or layers. The core fabric is frequently a woven fabric, although other structures are known. The core fabric is structured to accommodate the mechanical stresses imposed in order to move the press felt, to resist undue compaction as it passes through the nip or nips, and to support the absorbent layer. The absorbent layer is generally at least one layer of fibrous batt, typically applied to the core fabric by a needle punching process. The absorbent layer may also comprise a porous foam or other material having sufficient strength, resistance to compaction, and void volume so as to be effective in a press felt. If an absorbent layer is attached to only one surface of the core fabric, it will typically be applied to the paper side surface of the core fabric.

[0006] If more than one layer of batt is applied to either or both of the machine side and the paper side of the core fabric, successive batt layers may be comprised of relatively finer fibres. This will increase the smoothness of the paper side of the press felt. It is also known to mix yarn sizes within one or more layers.

[0007] It is also known that the paper side surface of a press felt should provide as high a degree as possible of contact between the paper side surface of the press felt and the wet paper web, so as to provide, amongst other things, good support to the wet paper web in the press nip. A high degree of contact also promotes uniform dewatering of the wet paper web. A common means of improving the degree of contact between the paper side surface of the batt and the wet paper web is to needle, or otherwise attach, a so-called capping layer of fine batt fibres onto the paper side surface of the batt.

[0008] When the batt is applied to the core fabric, and attached to it typically by needle punching, in theory the batt fibres are more or less randomly oriented so that on a macro scale the batt appears to be isotropic. On a micro scale, at the paper side surface of the batt that is in contact with the wet paper web in the nip, this is not the case. At the interface between the paper side surface of the batt and the wet paper web, the distribution of contact points is found to be irregular. There are regions in the paper side surface of the batt which provide relatively large numbers of contact points between the paper side surface of the batt and the wet paper web, and there are other regions in which the number of contact points is fewer.

[0009] It has now been recognised that the observed micro scale anisotropic distribution of contact points between the paper side surface of the batt and the wet paper web results in uneven application of the roll pressure to the wet paper web carried on the press felt in the roll nip, so that the pressure applied to the wet paper web along the length of the notional contact line comprising the nip between, for example, a pair of rotating rollers, varies along the length of the contact line, across the press. This variation results in uneven water removal from the wet paper web. It also follows that as the press felt carrying the wet paper web moves through the nip, the pressure distribution along the contact line is constantly varying, due to the anisotropic distribution of the batt fibres at the interface between the batt paper side surface and the wet paper web. It has been observed that the anisotropic nature of the batt can cause less than optimum dewatering of the wet paper web, and can also mark the wet paper web. It has also been observed that the use of a surface layer of batt of smaller fibres does not solve this problem. Although this surface layer of smaller fibre batt does appear to provide somewhat better support to the wet paper web in

the nip, there are several disadvantages. The support provided to the wet paper, particularly for both light weight paper sheets, and relatively dry paper sheets (which are thinner) is far from optimal, as the points of support are still somewhat randomly scattered. Furthermore, the use of smaller fibres results in high press felt wear, thus unduly diminishing the working life of the press felt.

[0010] Hitherto it has been assumed that the various processes involved in creating an absorbent batt layer, such as carding, needling, cross-lapping and others, would inherently ensure that the batt paper side surface fibres forming the interface between the press felt and the wet paper web are both randomly oriented and evenly distributed within the batt. However, microscopic examination of the paper side surface of a typical batt layer forming part of a press felt shows that this is not the case. Although the fibres are more or less randomly oriented, there is a very wide distribution in the spacing between the pints of contact between the paper side surface of the batt and the wet paper web.

[0011] It has been proposed to mitigate these effects by using thinner fibres in greater number within the batt. While this does appear to result in more void spaces within the batt, the water passages through the batt are also reduced in size, which diminishes the water removal capacity of the press felt.

BRIEF SUMMARY OF THE INVENTION.

[0012] It has now been discovered that improved press section efficiency, in terms of the amount of water removed from the wet paper web, can be obtained by providing a relatively uniform porous surface layer on the paper side of the press felt, in which the distribution of the contact points is both effectively uniform, and the contact points are located relatively close together. This substantially uniform porous layer is constructed and arranged to provide an interface between the paper side surface of the press felt and the wet paper web which has a very uniform distribution of more or less equally spaced contact points, together with a more or less uniformly spaced drainage openings through the porous layer into the batt layer. The porous layer appears to be most effective when the distance between adjacent contact points between the wet paper web and the paper side surface of the porous layer is approximately equal to, or is less than, the thickness of the wet paper web at mid-nip as it passes through the press.

[0013] It has now been discovered that the anisotropic nature of the paper side batt surface of a press felt, forming the interface between the press felt and the wet paper web, can be overcome at least in part by providing a relatively smooth and uniformly porous surface layer on the paper side surface of the press felt. The provision of a uniform porous layer at the interface appears to bridge over the contact areas of the batt paper side surface and thus supports the wet paper web better, so as to improve pressing efficiency and observed paper consistency on exit from the press section.

[0014] Thus in its broadest embodiment this invention seeks to provide a composite press felt, comprising at least three layers wherein:

(i) the first layer comprises a core fabric, having a machine side surface and a paper side surface;
(ii) the second layer comprises at least one absorbent layer having a machine side surface and a paper side surface which is attached on its machine side surface to the paper side surface of the core fabric; and
(iii) the third layer comprises a substantially smooth and substantially uniformly porous layer having a machine side surface and a paper side surface, which is attached on its machine side surface to the paper side surface of the second layer.

[0015] Preferably, the core fabric is a woven fabric. More preferably, the core fabric comprises a single layer or a multilayer woven fabric.

[0016] Preferably, the second layer comprises one or more layers of batt material attached by needling to the first layer. More preferably, the second layer comprises at least two layers of batt material.

[0017] Preferably, the third layer is chosen from the group consisting of: a fine woven fabric; a porous film sheet; and a porous film obtained by heating a layer of an at least partially fusible powder material applied to the paper side surface of the third layer.

[0018] Preferably, the distance between adjacent contact points between the wet paper web and the paper side surface of the porous layer is approximately equal to the thickness of the wet paper web at mid-nip as it passes through the press. More preferably, the distance between adjacent contact points between the wet paper web and the paper side surface of the porous layer is from about 25% to about 100% of the thickness of the wet paper web at mid-nip as it passes through the press.

BRIEF DESCRIPTION OF THE DRAWINGS.

[0019] In the attached drawings:

Figure 1 shows a micrograph of the surface of a batt layer;
Figure 2 shows a micrograph of the surface of a fabric porous layer;
Figure 3 shows a schematic cross section of a press felt of this invention when compressed; and
Figure 4 shows a schematic diagram of a press felt testing device.

DETAILED DESCRIPTION OF THE DRAWINGS

[0020] Referring first to Figure 1, there is shown a photograph of the paper side surface of a press felt that is exposed to 6.3 MPa pressure so as to duplicate the effect experienced by the press felt at the midpoint of a typical press nip. The photograph is a 100x magnification of the batt surface, which is comprised of very fine, 6.7 dtex fibres; the batt has been needled to a standard, double layer woven base fabric. The dark regions of the photograph show areas of contact between the batt and the nip, while the white areas are effectively drainage openings into the batt structure below this surface. The photograph thus depicts the interface between the paper side surface of the batt and wet paper web as they pass together through the press nip.

[0021] On a macroscopic scale, the batt fibres appear to be randomly located and thus uniformly dispersed. Figure 1 shows that, on a microscopic scale, the batt fibres 1 are not randomly and uniformly dispersed; the contact areas and drainage openings on the surface interface of the batt and the wet paper web are in fact unevenly dispersed on the paper side surface of the batt. The photograph clearly shows a concentration of contact points at A, an absence of contact points at C, and an intermediate number at B. The consequence of this uneven distribution is that, on a microscopic scale, some regions of the web will be exposed to pressure in the nip, such as those above the points A, while others, such as those above C, will experience little or no pressure, thus leading to uneven dewatering of the web and less than optimum consistency at nip exit.

[0022] Figure 2 is a 100x magnification photomicrograph of the paper side surface of a uniformly porous surface layer such as would be used in the press felts of the present invention. In this photograph, the porous layer is a 400 mesh (157.5 strands per cm) stainless steel woven fabric, the individual strands of which are 26 microns in diameter (roughly equivalent to a size of 10 dtex). This fabric was obtained from F.P. Smith Wire Cloth Co. of Northlake, IL. It was then attached to a rubber backing and pressed at 6.3 MPa using the same laboratory press as was used to obtain the photograph of Figure 1. The rubber backing was provided to assist in simulating the compression characteristics of a press felt upon which the porous layer would normally be attached in the fabrics of this invention. In use, the porous layer would be laid over the absorbent layer. However, Figure 2 is intended to illustrate the uniform distribution of equally spaced contact points and drainage openings at the interface between the fabric and a web in the nip.

[0023] It will be seen from Figure 2 that the contact points 3 between the fabric and the web, and hence the drainage openings between these contact points, are uniformly arranged. It is thus apparent that a paper web that is pressed in a nip using a press felt having a paper side surface that is provided with a uniform distribution of contact points and drainage openings will experience a more even and uniform distribution of pressure than a web that is pressed using a batt as shown in Figure 1. This even distribution of pressure, combined with the uniform distribution of drainage openings in the paper side surface of the porous layer, will provide more even dewatering of the web, thus a higher paper consistency upon exiting the nip, than a press felt provided with a batt having typical surface characteristics with uneven distribution of contact points.

[0024] The effect of compression on a batt provided with a uniformly porous layer in accordance with this invention is shown diagrammatically in Figure 3. Figure 3 is intended to represent a high magnification cross section taken from the paper side surface toward the machine side surface through a uniformly porous fabric located on the paper side surface of a press felt batt. In this Figure, the uniformly porous fabric is indicated generally at 7, the press felt batt is 2, contact regions in the porous fabric are shown as 3, drainage openings in this fabric are indicated at 4, while 5 designates the random fibres in the paper side surface of the batt shown generally as 2. It will be understood that the porous fabric 1 may be a woven structure, a perforated film, or porous film obtained by heating a layer of at least partially fusible powder material. Microscopic regions in the batt having relatively lower elevation are shown as B, while those regions closest to the interface with the uniform porous layer are indicated as A. The batt and porous layer are shown as being under compression as if in a press nip. It will be seen that, following compression in the nip, the added porous layer 7 effectively bridges the lowered areas B in the compressed batt 2, and provides uniformly distributed support as at 8 for the wet paper web while under compression in the press nip to remove water from it through drainage openings 4.

[0025] The porous layer in the press felts of this invention can take several forms, and can be attached to the batt surface in several ways.

[0026] In one embodiment, the porous layer comprises a fabric which is applied to the exposed face of the batt, and attached to the batt by any suitable means, such as gluing. Alternatively, a relatively narrow fabric strip can be used, which is attached to the core fabric using a spiral winding technique, essentially as described by Best et at US 5,268,076 or by Rexfelt, US 5,360,656.

[0027] In a second embodiment, a porous film is used, which can be applied by the same techniques as are used for a porous fabric layer. The film as applied can also be non-porous, and is rendered porous after attachment to the batt either by mechanical means or by removal of a labile component under the influence of heat or a solvent.

[0028] In a third embodiment, a powder material is applied to the batt porous layer surface, and converted into a porous film by heating.

[0029] In both the second and third embodiments the

film can be applied to the full width of the pressfelt, or a variation of the Best et al. or Rexfelt techniques can be employed.

[0030] A laboratory test was carried out in which comparison was made between the same press felt both with, and without, a surface fabric according to this invention. The essential parts of the press roll test unit are shown diagrammatically in Figure 4. The test unit 10 contains a pair of opposed rolls 11, 12 which are urged together to provide the required nip pressure by a force applied essentially in the direction of the arrow 13. The test sample of press felt 14 is looped around only the lower roll 12. The test samples of paper are contained in the wet tray 15, and transferred by hand onto the press felt under test. The press felt sample circulates past the guides 16, 17 to maintain its alignment in the test unit. The doctor blade 20 serves to remove excess surface water from the surface of the roll 11 after is has passed through the roll nip. The pair of rolls 11, 12 rotate in the directions indicated by the arrows 18, 19. Both the speed of rotation of the rolls, and the applied load, can be separately varied.

[0031] The test procedure is as follows. A supply of paper, typically a sheet (or sheets) of a newsprint grade of about 50 gsm, about 38mm x 25mm in size and of a known weight per sheet, is presoaked overnight in deionised water. The press felt sample is cut to provide a belt of appropriate length and about 100mm in width. The belt is then placed on the test unit and preconditioned by circulation through the roll nip saturated with water and under a line load of 26kN/m. The belt typically completes from about 9,000 - 10,000 rotation cycles prior to testing. The felt is then allowed to dry until a moisture level of 30 - 35% is reached. The wet paper sample is blotted to remove excess free water, placed on the test felt, and passed through the roll nip at the desired nip load and press felt speed. After removal from the top roll 11 by the doctor blade, the wet sheet is reweighed to determine its consistency. In this test, the porous layer was a layer of stainless steel fabric woven in a plain weave with a mesh count of about 16 wires/mm, woven from wires with a diameter of about 0.028mm. Comparison of the exit paper consistency from the test unit with the fabric in place, compared to paper consistency without the fabric in place, showed a reproducible improvement in paper consistency of between 3% and at least 5%.

Claims

1. A composite press felt comprising at least three layers wherein:

    (i) the first layer comprises a core fabric, having a machine side surface and a paper side surface;
    (ii) the second layer comprises at least one absorbent layer having a machine side surface and a paper side surface which is attached on its machine side surface to the paper side surface of the core fabric; and
    (iii) the third layer comprises a substantially smooth and substantially uniformly porous layer having a machine side surface and a paper side surface, which is attached on its machine side surface to the paper side surface of the second layer.

2. A press felt according to Claim 1 wherein the first layer is a woven fabric.

3. A press felt according to Claim 2 wherein the first layer is a single layer or a multilayer woven fabric.

4. A press felt according to Claim 1 wherein the second layer comprises one or more layers of batt material attached by needling to the first layer.

5. A press felt according to Claim 4 wherein the second layer comprises two layers of batt material.

6. A press felt according to Claim 1 wherein the third layer is chosen from the group consisting of: a fine woven fabric; a porous film sheet; and a porous film obtained by heating a layer of fusible powder material applied to the paper side surface of the third layer.

7. A press felt according to Claim 1 wherein the distance between adjacent contact points between the wet paper web and the paper side surface of the porous layer is approximately equal to the thickness of the wet paper web at mid-nip as it passes through the press.

8. A press felt according to Claim 1 wherein the distance between adjacent contact points between the wet paper web and the paper side surface of the porous layer is from about 25% to about 100% of the thickness of the wet paper web at mid-nip as it passes through the press.

FIGURE 1

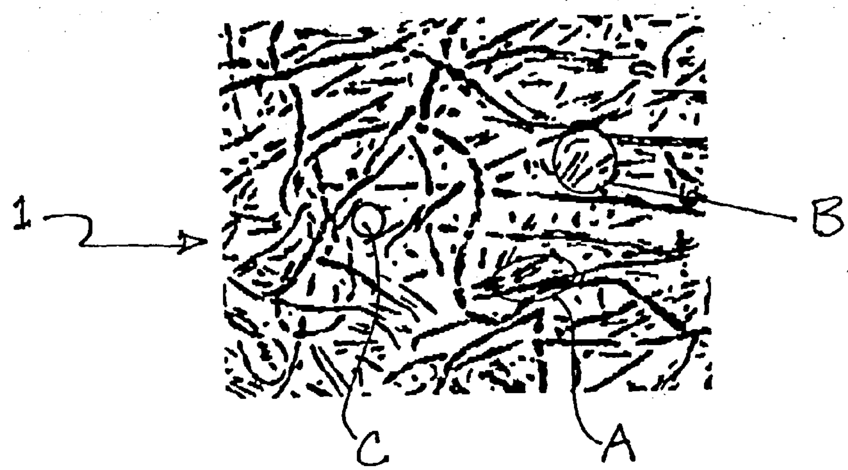
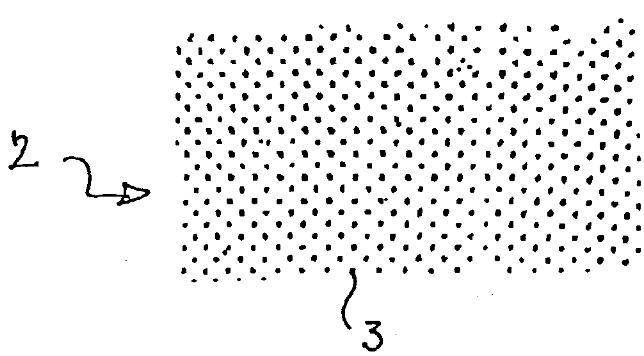


FIGURE 2



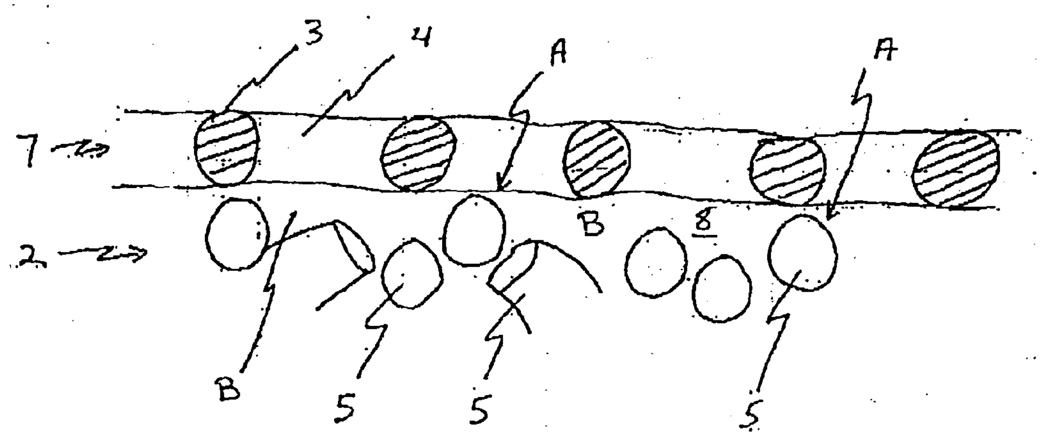


FIGURE. 3

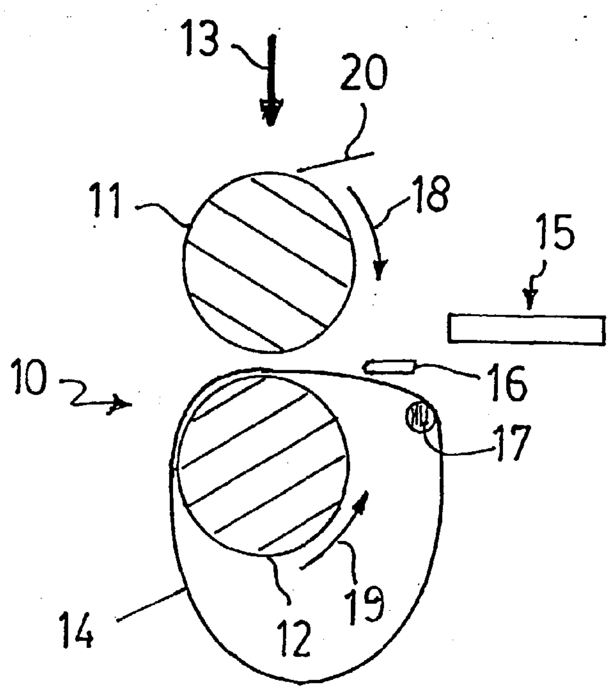


FIG.4